

## CLAIMS

What is claimed is:

- 1 1. A method for determining one or more fine-tuned estimates of delay value associated  
2 with a received signal, the method comprising the computer-implemented steps of:  
3 determining a range of delay values of interest associated with the received signal;  
4 interpolating fine-grained values for I and Q correlation integrals by using a subset of  
5 coarse-grained calculations of I and Q correlation integrals; and  
6 determining the one or more fine-tuned estimates of delay value based on the fine-  
7 grained values of I and Q correlation integrals.
- 1 2. The method of Claim 1, wherein determining a range of delay values of interest  
2 further comprises the steps of:  
3 determining one or more initial estimates of the delay value;  
4 selecting one of the one or more initial estimates of delay value to be a selected initial  
5 estimate of delay value; and  
6 selecting a range of delay values in the neighborhood of the selected initial estimate  
7 of delay value to be the range of delay values of interest.
- 1 3. The method of Claim 2, wherein selecting a range of delay values in the  
2 neighborhood of the selected initial estimate of delay value to be the range of delay  
3 values of interest is a function of the selected initial estimate of delay value and a pre-  
4 selected confidence level.

1 4. The method of Claim 1, wherein the subset of coarse-grained calculations of I and Q  
 2 correlation integrals is based on:  
 3 a pre-selected desired accuracy; and  
 4 a type of filter that was used to filter the received signal.

1 5. The method of Claim 2, wherein determining the one or more initial estimates of the  
 2 delay value further comprises the steps of:  
 3 performing, if not already performed, a coarse-grained calculation of I and Q  
 4 correlation integrals over a hypothesized range of delay values for a sampled  
 5 data that is associated with the received signal;  
 6 calculating magnitude values corresponding to the coarse-grained calculations of I  
 7 and Q correlation integrals over the hypothesized range of delay values; and  
 8 selecting a delay value that corresponds to a highest magnitude value corresponding  
 9 to the coarse-grained calculations of I and Q correlation integrals as the one or  
 10 more initial estimates of delay value.

1 6. The method of Claim 2, wherein determining the one or more initial estimates of  
 2 delay value further comprises the steps of:  
 3 performing, if not already performed, a coarse-grained calculation of I and Q  
 4 correlation integrals over a hypothesized range of delay values for a sampled  
 5 data that is associated with the received signal;  
 6 calculating magnitude values corresponding to the coarse-grained calculations of I  
 7 and Q correlation integrals over the hypothesized range of delay values; and







interpolating fine-grained values for I and Q correlation integrals by using a subset of coarse-grained calculations of I and Q correlation integrals;  
calculating magnitude values corresponding to the fine-grained values of I and Q correlation integrals over the range of delay values of interest; and  
selecting one or more delay values that corresponds to a highest magnitude value corresponding to the fine-grained values of I and Q correlation integrals as the one or more fine-tuned estimates delay value.

15. A method for determining one or more fine-tuned estimates of delay value associated with a received signal, the method comprising the computer-implemented steps of:  
determining an initial range of delay values of interest associated with the received signal;  
performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over the initial range of delay values for a sampled data that is associated with the received signal;  
calculating a magnitude of the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of delay values; and  
selecting a delay value from the hypothesized range of delay values that correspond to a highest magnitude value that corresponds to the coarse-grained calculations of I and Q correlation integrals as an initial estimate of delay value;  
selecting a range of delay values in the neighborhood of the initial estimate of delay value to be a range of delay values of interest;  
generating a parametric template that represents I and Q correlation integrals associated with the received signal; and

17 performing a linear regression on the range of delay values of interest to produce a  
18 delay error function that is based on the range of delay values of interest; and  
19 selecting from the range of delay values of interest one or more delay values that  
20 minimize the delay error function as the fine-tuned estimates of delay value.

1 16. The method of Claim 15, wherein the step of selecting from the range of delay values  
2 of interest one or more delay values that minimize the delay error function comprises  
3 the steps of:  
4 from the range of delay values of interest, selecting a target delay value that produces  
5 a minimum value of the delay error function; and  
6 from the range of delay values of interest, selecting a range of delay values around the  
7 target delay value as the one or more fine-tuned estimates of delay value.

1 17. The method of Claim 15, wherein the step of selecting from the range of delay values  
2 of interest one or more delay values that minimize the delay error function comprises  
3 the steps of:  
4 selecting from the range of delay values of interest one or more delay values for  
5 which the delay error function is below a pre-selected threshold value of the  
6 delay error function as the one or more fine-tuned estimates delay value.

1 18. A method for determining one or more fine-tuned estimates of carrier frequency value  
2 associated with a received signal, the method comprising the computer-implemented  
3 steps of:

4 determining a range of carrier frequency values of interest associated with the  
 5 received signal;  
 6 interpolating fine-grained values for I and Q correlation integrals by using a subset of  
 7 coarse-grained calculations of I and Q correlation integrals; and  
 8 determining the one or more fine-tuned estimates of carrier frequency value based on  
 9 the fine-grained values of I and Q correlation integrals.

1 19. The method of Claim 18, wherein determining a range of carrier frequency values of  
 2 interest further comprises the steps of:  
 3 determining one or more initial estimates of carrier frequency value;  
 4 selecting one of the one or more initial estimates of carrier frequency value to be a  
 5 selected initial estimate of carrier frequency value; and  
 6 selecting a range of carrier frequency values in the neighborhood of the selected  
 7 initial estimate of carrier frequency value to be the range of carrier frequency  
 8 values of interest.

1 20. The method of Claim 18, wherein the subset of coarse-grained calculations of I and Q  
 2 correlation integrals is based on:  
 3 duration of the I and Q correlation integral;  
 4 a pre-selected confidence level; and  
 5 a type of filter that was used to filter the received signal.



21. The method of Claim 19, wherein determining the one or more initial estimates of carrier frequency value further comprises the steps of:

- performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of carrier frequency values for a sampled data that is associated with the received signal;
- calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency values; and
- selecting a carrier frequency value that corresponds to a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals as the one or more initial estimates of carrier frequency value.

1     22.     The method of Claim 19, wherein determining the one or more initial estimates of  
2     carrier frequency value further comprises the steps of:  
3     performing, if not already performed, a coarse-grained calculation of I and Q  
4     correlation integrals over a hypothesized range of carrier frequency values for  
5     a sampled data that is associated with the received signal;  
6     calculating magnitude values corresponding to the coarse-grained calculations of I  
7     and Q correlation integrals over the hypothesized range of carrier frequency  
8     values; and  
9     selecting one or more carrier frequency values that correspond to magnitude values  
10     that are above a pre-selected threshold magnitude value as the one or more  
11     initial estimates of carrier frequency value.

23. The method of Claim 19, wherein determining the one or more initial estimates of carrier frequency value further comprises the steps of:

performing, if not already performed, a coarse-grained calculation of I and Q correlation integrals over a hypothesized range of carrier frequency values for a sampled data that is associated with the received signal;

calculating magnitude values corresponding to the coarse-grained calculations of I and Q correlation integrals over the hypothesized range of carrier frequency values;

determining a highest magnitude value corresponding to the coarse-grained calculations of I and Q correlation integrals; and

selecting one or more carrier frequency values that correspond to magnitude values that are within a pre-selected magnitude range around the highest magnitude value as the one or more initial estimates of carrier frequency value.

1     24.     The method of Claim 18, wherein the received signal is associated with a global  
2     positioning satellite vehicle.

1     25.     The method of Claim 18, wherein determining the one or more fine-tuned estimates  
2             of carrier frequency value based on the fine-grained values of I and Q correlation  
3             integrals comprises the steps of:  
4             calculating magnitude values corresponding to the fine-grained values of I and Q  
5             correlation integrals over the range of carrier frequency values of interest; and

6 selecting one or more carrier frequency value that correspond to a highest magnitude  
7 value corresponding to the fine-grained values of I and Q correlation integrals  
8 as the one or more fine-tuned estimates carrier frequency value.

1 26. The method of Claim 18, wherein determining one or more fine-tuned estimates of  
2 carrier frequency value based on the fine-grained values of I and Q correlation  
3 integrals comprises the steps of:  
4 calculating magnitude values corresponding to the fine-grained values of I and Q  
5 correlation integrals over the range of carrier frequency values of interest; and  
6 selecting one or more carrier frequency values that correspond to magnitude values  
7 that are above a pre-selected threshold magnitude value as the one or more  
8 fine-tuned estimates carrier frequency value, respectively.

1 27. The method of Claim 18, wherein determining one or more fine-tuned estimates of  
2 carrier frequency value based on the fine-grained values of I and Q correlation  
3 integrals comprises the steps of:  
4 calculating magnitude values corresponding to the fine-grained values of I and Q  
5 correlation integrals over the range of carrier frequency values of interest;  
6 determining a highest magnitude value corresponding to the fine-grained values of I  
7 and Q correlation integrals; and  
8 selecting one or more carrier frequency values that correspond to magnitude values  
9 that are within a pre-selected magnitude range around the highest magnitude  
10 value as the one or more fine-tuned estimates carrier frequency value.

1 28. A method for determining one or more fine-tuned estimates of carrier frequency value  
2 associated with a received signal, the method comprising the computer-implemented  
3 steps of:  
4 performing, if not already performed, a coarse-grained calculation of I and Q  
5 correlation integrals over a hypothesized range of carrier frequency values for  
6 a sampled data that is associated with the received signal;  
7 calculating a magnitude of the coarse-grained calculations of I and Q correlation  
8 integrals over the hypothesized range of carrier frequency value; and  
9 selecting a carrier frequency value from the hypothesized range of carrier frequency  
10 value that correspond to a highest magnitude value that corresponds to the  
11 coarse-grained calculations of I and Q correlation integrals as an initial  
12 estimate of carrier frequency value;  
13 selecting a range of carrier frequency values in the neighborhood of the initial  
14 estimate of carrier frequency value to be a range of carrier frequency values of  
15 interest;  
16 interpolating fine-grained values for I and Q correlation integrals by using a subset of  
17 coarse-grained calculations of I and Q correlation integrals;  
18 calculating magnitude values corresponding to the fine-grained values of I and Q  
19 correlation integrals over the range of carrier frequency values of interest; and  
20 selecting one or more carrier frequency value that corresponds to a highest magnitude  
21 value corresponding to the fine-grained values of I and Q correlation integrals  
22 as the one or more fine-tuned estimates carrier frequency value.



23 selecting from the range of carrier frequency values of interest one or more carrier  
24 frequency values that minimize the carrier frequency error function as the  
25 fine-tuned estimates of carrier frequency value.

30. The method of Claim 29, wherein the step of selecting from the range of carrier frequency values of interest one or more carrier frequency values that minimize the carrier frequency error function comprises the steps of:

from the range of carrier frequency values of interest, selecting a target carrier frequency value that produces a minimum value of the carrier frequency error function; and

from the range of carrier frequency values of interest, selecting a range of carrier frequency values around the target carrier frequency value as the one or more fine-tuned estimates of carrier frequency value.

31. The method of Claim 29, wherein the step of selecting from the range of carrier frequency values of interest one or more carrier frequency values that minimize the carrier frequency error function comprises the steps of:

selecting from the range of carrier frequency values of interest one or more carrier frequency values for which the carrier frequency error function is below a pre-selected threshold value of the carrier frequency error function as the one or more fine-tuned estimates carrier frequency value.

1 32. A method for determining one or more fine-tuned estimates of parameter values  
 2 associated with a received signal, the method comprising the computer-implemented  
 3 steps of:  
 4 determining a range of parameter values of interest associated with the received  
 5 signal;  
 6 interpolating fine-grained values for I and Q correlation integrals by using a subset of  
 7 coarse-grained calculations of I and Q correlation integrals; and  
 8 determining the one or more fine-tuned estimates of parameter value based on the  
 9 fine-grained values of I and Q correlation integrals.

1 33. The method of Claim 32, wherein parameter values comprise a vector including all or  
 2 a subset of multipath characteristics, signal power, delay, and carrier frequency.

1 34. The method of Claim 32, wherein determining a range of parameter values of interest  
 2 further comprises the steps of:  
 3 determining one or more initial estimates of the parameter value;  
 4 selecting one of the one or more initial estimates of parameter value to be a selected  
 5 initial estimate of parameter value; and  
 6 selecting a range of parameter values in the neighborhood of the selected initial  
 7 estimate of parameter value to be the range of parameter values of interest.

1 35. The method of Claim 34, wherein selecting a range of parameter values in the  
 2 neighborhood of the selected initial estimate of parameter value to be the range of

3 parameter values of interest is a function of the selected initial estimate of parameter  
4 value and a pre-selected confidence level.

1 36. The method of Claim 34, wherein determining the one or more initial estimates of the  
2 parameter value further comprises the steps of:  
3 performing, if not already performed, a coarse-grained calculation of I and Q  
4 correlation integrals over a hypothesized range of parameter values for a  
5 sampled data that is associated with the received signal;  
6 calculating magnitude values corresponding to the coarse-grained calculations of I  
7 and Q correlation integrals over the hypothesized range of parameter values;  
8 and  
9 selecting a parameter value that corresponds to a highest magnitude value  
10 corresponding to the coarse-grained calculations of I and Q correlation  
11 integrals as the one or more initial estimates of parameter value.

1 37. The method of Claim 34, wherein determining the one or more initial estimates of  
2 parameter value further comprises the steps of:  
3 performing, if not already performed, a coarse-grained calculation of I and Q  
4 correlation integrals over a hypothesized range of parameter values for a  
5 sampled data that is associated with the received signal;  
6 calculating magnitude values corresponding to the coarse-grained calculations of I  
7 and Q correlation integrals over the hypothesized range of parameter values;  
8 and





6 performing, if not already performed, a coarse-grained calculation of I and Q  
7 correlation integrals over the initial range of parameter values for a sampled  
8 data that is associated with the received signal;  
9 calculating a magnitude of the coarse-grained calculations of I and Q correlation  
10 integrals over the hypothesized range of parameter values; and  
11 selecting a parameter value from the hypothesized range of parameter values that  
12 correspond to a highest magnitude value that corresponds to the coarse-  
13 grained calculations of I and Q correlation integrals as an initial estimate of  
14 parameter value;  
15 selecting a range of parameter values in the neighborhood of the initial estimate of  
16 parameter value to be a range of parameter values of interest;  
17 generating a parametric template that represents I and Q correlation integrals  
18 associated with the received signal; and  
19 performing a linear regression on the range of parameter values of interest to produce  
20 a parameter error function that is based on the range of parameter values of  
21 interest; and  
22 selecting from the range of parameter values of interest one or more parameter values  
23 that minimize the parameter error function as the fine-tuned estimates of  
24 parameter value.

1 40. The method of Claim 39, wherein the step of selecting from the range of parameter  
2 values of interest one or more parameter values that minimize the parameter error  
3 function comprises the steps of:

4 from the range of parameter values of interest, selecting a target parameter value that  
5 produces a minimum value of the parameter error function; and  
6 from the range of parameter values of interest, selecting a range of parameter values  
7 around the target parameter value as the one or more fine-tuned estimates of  
8 parameter value.

1 41. The method of Claim 39, wherein the step of selecting from the range of parameter  
2 values of interest one or more parameter values that minimize the parameter error  
3 function comprises the steps of:  
4 selecting from the range of parameter values of interest one or more parameter  
5 values for which the parameter error function is below a pre-selected  
6 threshold value of the parameter error function as the one or more fine-tuned  
7 estimates parameter value.